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AUTHOR Bikson, T. K.; And Others

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ABSTRACT

This prospectus describes a new research consortium, the Institute for Interactive Information Environments (IIIE), whose mission is to improve understanding of the implementation of advanced information technology in organizational settings. The first of five major sections of the report, the introduction provides background information on the mission, objectives, organization, and initial activities of the institute. The second section discusses the research agenda, including criteria for the selection of projects, and describes research projects proposed in each of three major areas: implementation paradigm development, impacts on group and individual performance, and information environments for the 1990s. The proposed research methods discussed in the third section include longitudinal field studies, cross-sectional field studies, policy analysis, modeling/simulation and secondary analysis, laboratory experimentation and prototype development, and elite interviews. Plans for the dissemination of research results and products are also outlined. The fourth section describes the research environment at the Rand Corporation, emphasizing its reputation for strong, independent research and special areas of expertise. The position of IIIE as a special research and educational organization within Rand's Domestic Research Division and the working relationships of organizational sponsors and IIIE are outlined in the fifth section, and the governance of the institute is described. A list of 24 representative Rand publications is included. (BBM)

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PREFACE

This Note presents the prospectus for a research consortium to be established by The Rand Corporation: The Institute for Interactive Information Environments (IIIE). The development of the prospectus has been sponsored jointly by the National Science Foundation and The Rand Corporation.

The proposed research agenda was initially developed at Rand and subsequently refined in collaboration with prospective sponsors of the IIIE. This process culminated in a three-day conference, hosted by Rand in May 1985, at which industry and government representatives, Rand staff, and invited experts met to shape the IIIE's specific research objectives.

Many individuals have contributed to this document. The principal authors particularly wish to thank Dr. Robert Anderson, consultant to The Rand Corporation, for providing an insightful review.

Individuals interested in more information about the IIIE should contact Dr. David Lyon, Vice President of Rand's Domestic Research Division, or Dr. Thomas Lodahl, Director of the Institute, at the following address:

The Rand Corporation
1700 Main Street
P.O. Box 2138
Santa Monica, CA 90406-2138

Telephone: (213)-393-0411

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SUMMARY

The users and vendors of advanced information technology share the challenge of capitalizing on technological opportunities. Information tools are becoming faster and more powerful, while the costs of computation, memory, and storage decline. But developing and implementing large information systems are expensive and risky undertakings with many pitfalls and few precedents. Once implemented within an organization, such systems are powerful and pervasive--their use can transform the characteristics of the work, the workforce, work settings, and the organization itself. And as systems create new interactive environments, they may provide the capability and stimulate the demand for the continual introduction of advanced electronic tools. It is difficult for both users and vendors to understand and anticipate the complex interactions of use, demand, and design.

PURPOSE OF THE INSTITUTE

To help organizations meet this challenge, The Rand Corporation has proposed the formation of a new research consortium, the Institute for Interactive Information Environments (IIIE). Broadly stated, the Institute's mission is to improve understanding of the implementation of advanced information technology in organizational settings. More specifically, the Institute has four guiding objectives:

1. To study the implementation of advanced information technology from both technical and social perspectives, and in the context of public and private policy deliberations.
2. To target key problems and opportunities associated with implementation, and to project how these will evolve as technologies develop further and organizations change in response.
3. To identify, devise, adapt, or evaluate research-based tools that can aid vendor and user organizations in the development and use of advanced information technology.

4. To transfer Institute findings and tools in a timely and useful manner by involving organizations in the research on a collaborative, interactive basis and by communicating the research products in forms appropriate to sponsors' needs.

The IIIE's consortium structure is based on the model of the National Science Foundation's Industry-University Cooperative Research Centers, which provide for close cooperation between users and providers of research results.[1] Under this structure, the initial IIIE mission and research agenda were defined by Rand research staff and then refined over a six-month period of collaboration with user and vendor organizations that were prospective sponsors of the Institute.

RESEARCH AGENDA

The IIIE has outlined a demanding interim research agenda that reflects its mission and objectives. Discussions with potential sponsors identified three issue areas of pressing concern:

- **Implementation Paradigm Development.** Research on the implementation of advanced information technology currently lacks a well-defined theoretical foundation. What are the critical success factors when organizations implement advanced information technology? What is the best conceptual framework for understanding and planning implementation? How can this framework be linked to an organization's long-term strategic planning?
- **Impacts on Organizational, Group, and Individual Performance.** Does an investment in advanced information technology pay off for an organization? How does the implementation of such technology enhance performance? How might it affect organizational structures and job design? What are appropriate ways of assessing implementation success, at the overall

[1]The National Science Foundation's Division of Industrial Science and Technological Innovation provided a planning grant, matched by The Rand Corporation, to explore the feasibility of extending this model to research on interactive information environments.

organizational performance level as well as for subunits and specific jobs? Can we devise value-added measures appropriate for both public and private sector assessments of information technology?

- **Information Environments for the 1990s**. What will the demand for interactive information technology in organizations look like five to ten years from now? What forces will shape and constrain it? What will be the behavioral settings for information work? Will the "office of the future" be an office as we now conceive it? What are the human resources implications of 1990s technology?

Within each issue area, the IIIE has proposed several research projects which, although they can be undertaken separately (as resources permit), are designed to complement one another. In September 1985, Rand staff will meet again with representatives from user and vendor organizations to focus the agenda more sharply and to define the Institute's first-year research program.

RESEARCH PRODUCTS AND PROCEDURES

The IIIE will be a rich resource for its sponsors. It will provide them with innovative intellectual tools, a setting for collaborative research, and interactive mechanisms for communicating research findings and products.

The goal of each project will be to develop one or more useful and innovative tools--frameworks, procedures, models--that are ready for direct application by user and vendor organizations. Important proposed products include a conceptual framework for understanding the implementation process, a new taxonomy of information objects, alternatives for redesigning jobs and workgroups, and assessments of standards policies.

IIIE research projects will rely on diverse methodologies, including field studies, conceptual development, policy analysis, modeling and simulation, prototype development, and interviews. The core methods will be coordinated field studies conceived as jointly constituting an "implementation laboratory"--a group of organizations

currently implementing large systems and willing to serve as research settings. In this real-world "laboratory," IIIE researchers will gather baseline information, test models, and examine the effects of alternative or experimental approaches to information technology change. The laboratory will yield one of the Institute's most important research products: an online implementation database (purged of identifying proprietary information) that sponsors can access to make their own directed inquiries.

Rand has a history of transferring research results in forms that are useful and appropriate to a range of clients, including decisionmakers. As a matter of corporate policy, research documentation is not limited to the technical report but includes executive summaries and research briefs, special-purpose documents, oral presentations, and workshops and conferences. Because the IIIE is a cooperative research program, dissemination of research products will occur throughout the course of the research. Sponsors will participate in biannual research development meetings, appoint half of the IIIE's ten-member Research Advisory Board, and be asked to review findings and products in early forms. They may also provide field sites and visiting research associates.

THE RAND RESEARCH ENVIRONMENT

Rand's unusually wide base of research experience and expertise make it a strong setting for the Institute. Rand is well-known for its rigorous standards of scientific quality and objectivity, and has repeatedly proven its capability to design, manage, and monitor large-scale, multidisciplinary research projects. Rand can also offer special expertise in areas central to the IIIE mission: a broad range of experience in social research and a history of significant contributions to computer and information sciences. Rand's reputation for strong, independent research has earned it a privileged position among both government and private sector organizations. This position makes it possible for Rand to give its sponsors the benefits of research based on proprietary information, properly protected, while avoiding conflicts of interest.

SPONSORSHIP

Sponsorship of the IIIE is open to both public- and private-sector organizations. IIIE sponsorship will especially benefit organizations in the forefront of information technology use that wish to collaborate in advancing the state of the art. In addition to helping define the research agenda and establishing research priorities, sponsors may also propose that the IIIE undertake specially funded research projects of particular interest to them and of relevance to the general agenda. Each sponsor will provide Rand a three-year research grant of $50,000 per year, renewable annually. Rand is seeking a sponsor group of 10 to 20 organizations.

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I. INTRODUCTION

This Note describes the research program and structure of a proposed new research institute at The Rand Corporation, the Institute for Interactive Information Environments (IIIE). Broadly stated, the Institute's mission is to improve understanding of the implementation of advanced information technology in organizational settings. More specifically, the Institute has four guiding objectives:

1. To study the implementation of advanced information technology from both technical and social perspectives, and in the context of public and private policy deliberations.
2. To target key problems and opportunities associated with implementation, and to project how these will evolve as technologies develop further and organizations change in response.
3. To identify, devise, adapt, or evaluate research-based tools that can aid vendor and user organizations in the development and use of advanced information technology.
4. To transfer Institute findings and tools in a timely and useful manner by involving organizations in the research on a collaborative, interactive basis and by communicating the research products in forms appropriate to sponsors' needs.

We have founded the Institute on a belief that today's technologically innovative organizations can provide a setting for research that will inform later generations of technology users, as well as provide insights for those who are currently trying high-risk innovations. The IIIE's initial funding has been provided by a grant from the National Science Foundation's Division of Industrial Science and Technological Innovation, matched by a grant from Rand, to test whether issues and procedures could be defined that would unite vendor and user organizations in a program of cooperative research on the implications of advanced information technology in organizational

settings. The IIIE's consortium structure is based on the National Science Foundation's Industry-University Cooperative Research Centers model, which provides for close cooperation between users and providers of research. Our hope is that with many organizations jointly funding research on a continuing basis, a broader range of questions can be addressed and longer-term studies can be undertaken.

An initial research agenda for the Institute was formulated by senior researchers at Rand and was refined over a six-month period in direct conversations with prospective sponsors. A revised agenda was prepared and a meeting of representatives from vendor and user organizations was held in May 1985 to solicit their reactions, learn about their research priorities, and develop a revised agenda representing our collective effort. This document presents the results of that meeting in the form of an extensively revised research agenda, a brief on Institute governance, and a description of Rand's qualifications for engaging in the proposed research.

We continue to seek sponsors in the forefront of advanced information technology development and use who are willing to provide both funds and, where appropriate, cooperation in the research itself. In addition to supporting general Institute projects, sponsors may propose specially funded projects within their organizations, provided that they are consonant with the IIIE's overall research directions. Our goal is to achieve a membership of about twenty sponsors.

The first sponsor meeting elicited strong interest and a number of verbal commitments for support. A second round of development activities is under way, with a follow-up meeting of prospective sponsors scheduled for September 1985 in Washington, D.C. On the basis of that meeting, Rand will make a start decision for the Institute and prepare its first-year research program.

The remainder of this prospectus consists of four sections and a bibliography. Section II outlines the interim research agenda and describes proposed projects and anticipated products. Section III addresses the rich mix of research methods that will support the agenda and explains plans for the interactive dissemination of research products. Section IV describes the research environment at The Rand Corporation, where the Institute is located. Section V explains conditions of

sponsorship and presents issues of Institute governance. The bibliography lists recent Rand publications pertinent to the implementation of advanced information technology.

II. RESEARCH AGENDA

The IIIE research agenda is under continuous development and review by sponsors and Rand staff. The agenda presented below represents the consensus developed at the first sponsor meeting, held in May 1985. The Institute does not expect to be able to undertake each project described here or to develop each product. The second sponsor meeting, to be held in September 1985, will address the issue of research priorities for the Institute's first year.

The IIIE agenda will include research projects of varying scope, focus, methodology, and output. The projects will be selected and designed so that they contribute in complementary ways to three major issue areas:

- **Implementation Paradigm Development**. What are the critical success factors when organizations implement advanced information technology? What is the best conceptual framework for understanding and planning implementation? How can this framework be linked to organizations' long-term strategic planning?
- **Impacts on Group and Individual Performance**. How should organizations measure the performance gains associated with the implementation of advanced information technology? How can they anticipate and assess the ways in which computer-based tools influence organizational structures and job designs?
- **Information Environments for the 1990s**. What will the demand for interactive information technology in organizations look like five to ten years from now? What forces will shape and constrain it? What might behavior settings for information work look like? What are the human resources implications of 1990s technology?

Each area subsumes several projects which can be undertaken separately or together. The goal of each project will be one or more useful and innovative tools--frameworks, procedures, models, prototypes--that will be communicated to sponsors in forms appropriate for direct application.

The research issues will be addressed with diverse methodologies, including field studies, conceptual development, policy analysis, modeling and simulation, prototype development, and interviews. The core methods are systematic field studies conceived as constituting an "implementation laboratory." This "laboratory" comprises organizations that are currently implementing or considering the implementation of large systems and that are willing to take part in an ongoing program of research. In this real-world laboratory, we will gather baseline information, test models or prototypes, and examine the effects of alternative organizational approaches to changing information technology.

The research products and projects proposed in each of the three major areas are summarized in Table 1.

IMPLEMENTATION PARADIGM DEVELOPMENT

Implementation is an adaptive process. To optimize both social and technological resources, an organization must not only adapt information technology to itself, but also adapt itself to the technology. To facilitate this process, we need to identify the critical dimensions of implementation success. This need becomes more pressing as organizations begin to design, develop, and deploy increasingly larger and more expensive information systems, committing important resources for several years and transferring major work processes to these new media.

Critical Features of Implementation Success

The chief goal within the implementation issue area is to provide a conceptual framework to guide user organizations in making choices about system design and implementation. Previous empirical work at Rand has established the outlines of such a framework; new empirical work in the implementation laboratory will refine it. When sufficiently developed,

Table 1

SUMMARY OF IIIE RESEARCH AGENDA

Issue Areas and Project Topics	Products[a]
Implementation paradigm development	
Implementation processes in user organizations	Conceptual framework, implementation database
Information in organizations: types, functions, users, tools	New taxonomy of information objects
Information flow among persons and information objects	Procedures for network and architecture planning
Training and learning situations and tactics in organizations	Context-sensitive models of learning support
Interface properties and system change	Guidelines for interface design
Impacts on organizational, group, and individual performance	
New technology and changes in organizational performance	Value-added models for assessing organizational performance
Group and individual effects of information technology	Alternatives for redesigning jobs and work groups
Information environments for the 1990s	
Influences and constraints on information technology demand	Demand models, demand forecasts, human resource projections, scenarios for behavioral settings for information work
Emerging patterns in supplier/user relationships	Alternative delivery scenarios
Sources, roles, and impacts of standards	Assessment of standards policies

[a]By *products* we mean not only reports but also documentation and relevant supporting material for system adaptations, prototypes, constructed models, and other technical outputs from the research.

the framework will identify alternative scenarios, single out critical features of the implementation process (What works? What doesn't?), and suggest strategies for reciprocal adaptation of work and work tools. The framework will include key dimensions of user contexts, interactive systems, and implementation strategies likely to affect successful technology transfer and use. It will also be linked to business strategies and other elements of long-term organizational planning.

The development of a conceptual framework will also yield another valuable product, an online implementation database. Data derived from the cross-sectional and longitudinal field studies in the implementation laboratory will be purged of identifying information, documented, and made available to sponsors who wish to make their own directed inquiries.

This effort will be supplemented by (though not dependent on) projects on several topics of special interest, including information types and information flows within organizations, and the influence of context and interface design on training and learning.

A New Taxonomy of Information Objects

There is currently no good way to define and classify the information objects--databases, messages, applications--that computer-based technology makes it possible to create and necessary to manage. A new taxonomy will help us investigate the way in which information technology is shaping current work and future demand: How is each class of object related to the business strategy, mission, and functions of the organization? What operations or processes need to be performed on each class of objects? What kinds of tools best support these processes or operations? Who will be their users?

Procedures for Network and Architecture Planning

Another project would complement the taxonomy project by developing a set of procedures for determining relationships among and between information objects and persons. Such procedures, based on an extension of existing sociometric methods, should help answer large-scale questions of system architecture. For instance, they should help guide

the planning of networks to support communications among persons and between persons and information objects. Of particular interest is the mix of support needed for working groups within an organization, such as a department or a project team (20 to 30 people who may not be collocated and who may enter into varying subgroups, depending on the task to be done). A pilot project examining self-configuring electronic subnetworks, for instance, might offer a productive exploratory approach. Another project might examine changing roles and relationships among communications management, data processing, and management information systems.

Context-Sensitive Models of Training/Learning

Without a strategic model of training and learning in context, it is difficult to determine what needs to be done, for what classes of users, and why. At the user level, we need to classify users and functions. Presumably, different types of information needs, tasks, tools, and prior experiences shape the kind of training and learning support needed. We will develop a model that includes the relative importance of such situational factors as occupational status of user, type of work, structure and mission of work group, previous computer experience, and criteria for career advancement. Once we can profile users in context, we can design and test appropriately varied training approaches that will maximize the benefits from powerful user-guided systems. For these purposes, it may be feasible to attempt experimental adaptation of some systems to provide improved interactive learning support. At the organizational level, we need to determine what mix of training types and learning resources is required and what informal skill diffusion exists. Finally, we need to test the generalizability of the models and approaches, so that we can address strategic issues, including the anticipation of training needs as technology changes and the appropriate allocation of training resources. The model will also provide ways of assessing alternative types and mixes of learning support (e.g., on-the-job training, classes, online help, informal skill transfer).

Guidelines for Interface Design

Interface design--encompassing all the major means by which systems and users come into contact, including applications, languages, and person-machine interaction mechanisms--seems critical to successful technological change. Features of interface design are included in most discussions of what makes systems useful and what makes system change easy or difficult.

We plan to look carefully, from linguistic and cognitive perspectives, at characteristics of interfaces and of human/system interaction that are likely to promote or impede use as systems evolve. In order to choose or modify interfaces intelligently, we need to study the tradeoffs involved: What are the comparative advantages and disadvantages of generic and specific tools? Simplicity vs. power? Manipulable vs. foolproof tools? What interface design properties are critical points from the user perspective in planning system change?

We also need a better understanding of the value and impact of multiple interface mechanisms. How do media differences (e.g., electronic mail vs. voice vs. print) affect person-person communication? How does modality (e.g., voice commands, touch screen, mouse, keyed commands) affect person-system interaction? What drives users' preferences in each case? Is it important to provide multiple access mechanisms for the same function? We may need to redefine and study "computer literacy" as meaning not a high level of expertise with one interface, but an acquired facility in learning new ones.

Exploratory work on implementation has been under way at Rand for several years and will continue in the field settings comprising the implementation laboratory. We expect that the interface design project will also involve laboratory work with hardware and software in controlled experimental settings.

IMPACTS ON ORGANIZATIONAL, GROUP, AND INDIVIDUAL PERFORMANCE

How may an investment in advanced information technology pay off for an organization? Will its implementation enhance performance, improve productivity? How else will it affect the organization? Many organizations have conducted cost-justification exercises that tap low-

level efficiency gains but fail to explore and represent broader kinds of performance changes. We need more appropriate ways of assessing implementation success, at the level of overall organizational performance as well as for subunits and specific jobs. For the public sector we need to develop appropriate measures of performance, enabling cross-sector comparisons of the uses and benefits of computer-based tools.

We must emphasize, however, that innovation inherently involves risk-taking. A justification for implementing advanced information technology is not likely to be reducible to input-output terms. Rather, the transition to these work-transforming tools will have subtle and pervasive effects that are not readily quantified. On the other hand, the new technology can often be implemented in stages, or in "chunks" (e.g., expandable networks, software modules). This permits organizations to work toward progressively more successful installations and to systematically reduce uncertainty about their effects over time.

Value-Added Models of Performance

We plan to approach the problem of assessing performance outcomes by developing systematic models of value-added gains and analyzing their sensitivity. Such models must apply to both the public and private sectors and should be highly differentiated; that is, they should be able to distinguish the contributions of direct and indirect resources (e.g., management vs. labor) and of different business units. The models should provide forward as well as after-the-fact assessment capability and be robust and reliable enough to use on a before-or-after basis for examining performance change. Finally, they should be compatible with existing accounting methods and other information sources.

Alternatives for Redesigning Jobs and Staffs

In addition to effects on performance, we need to understand how organizations will change as they adopt and adapt to advanced information technologies. There are many unanswered questions about effects on organizational structures and individual jobs that affect policy, planning, and quality of working life. For example, will

electronic communications flatten organizational hierarchies? Will broad access to information bases make decisionmaking more centralized or less? Will integrated systems lead to a redesigning of jobs by bundling tasks in new ways? How do technology properties and organizational policies interact to condition the results? We hope to develop effective strategies for anticipating technology-impelled organizational change and for reacting to unexpected opportunities for innovation.

INFORMATION ENVIRONMENTS FOR THE 1990s

Projects in this topic area will examine and attempt to predict the demand for interactive information environments through the next decade. What functions will users want? How sophisticated will users be? Technology forecasts from the supply side, in themselves, are not a research priority. Answers to questions about the kinds of technology that could be brought to the marketplace in 1990 and 1995 can be found today in vendors' R&D departments. But demand projections raise quite different issues: Vendors need to know what user organizations will want, given all that is technologically possible. (Vendors learned the hard way, for example, that users did not want electronic calendars.) User organizations need help in projecting their own demands for functionality to guide system planning for the next 5 to 10 years.

Projecting demand is a research challenge for which no successful precedents exist. The chief methods supporting our exploration will be analyses of existing data, together with modeling, simulation, and other laboratory methods, with field studies used chiefly for subsequent corroboration.

Demand Models and Forecasts

We particularly want to explore future organizational demand for applications, or "bundles of functionality," plus the software, hardware, and other equipment to support them. To begin, we need a baseline study of current demand and of the tools or applications in place now that provide probable starting points or leverage for future demand. In addition, we need to map major sources of inertia (e.g., embedded systems or programs) and to set some bounds on "affordability"

as a determinant (what organizations won't spend vs. what they think they can't afford not to do). We will also study the behavior of leading-edge and risk-taking organizations. The final step will be to generate hypotheses about demand and to experiment with methods for testing them.

Human resource implications for information environments in the 1990s should be studied from two standpoints: First, how will demand be affected as workers and organizations gain experience with advanced information systems? For instance, will more-experienced workers want highly modifiable systems? Second, what will be the expected size and skill mix for the white collar work force in the 1990s? For instance, what will be the effect on support staff? Will professionals or managers require less secretarial, clerical, and technical support? Or will support staffs increase in relative size because the new technology permits them to take over some of the professionals' and managers' traditional information-handling activities?

We will also examine implications of new technology on the behavior settings for information work in the near future. Historically, the settings for white collar work have been offices in which collocated groups of individuals worked on information-related processes or products in the service of some organizational mission. But as new tools relax old constraints on work environments and introduce new ones, the notion of "office" may be redefined, not only in physical and ergonomic terms, but in structural, psychological, and cultural terms as well. The word "office" itself may come to mean chiefly the system for accomplishing work and only secondarily the place(s) where the work is done. How will the physical "office" change in response to new information technology--for example, in terms of furniture, lighting, and space-use requirements? What are the implications of new kinds of behavior settings on organizations and individuals? What effects will they have on the experience of work and the quality of working life?

Alternative Delivery Scenarios

As part of the effort to understand 1990s technology, we need to examine several dimensions of the emerging patterns in supplier/supplier, supplier/user, and user/user relationships. Supplier/supplier relationships evidence a number of changes as computation and communication business interests merge and as equipment and software vendors undertake joint efforts. Supplier/user relationships are also changing. Supplier/user partnerships and ownerships are developing, and new types of information system service suppliers, such as system configuration providers and commercial database providers, are assuming a growing role. User/user relationships are also undergoing change. For instance, financial and other business interactions (e.g., customer purchases and billing, raw materials orders and invoicing) are being transferred to electronic media.

We will also examine changes in the actual mechanisms and infrastructures for delivering information and communications technology, as well as related support and other services. Mechanisms for the delivery of advanced technology are expected to exert increasing influence on demand and implementation processes.

Standards

The role and impact of standards may vary, depending on the scale and rate of change envisioned, as well as the particular technology arena. When technology is fairly stable, for example, standards might define markets; in contrast, when technology is still changing rapidly, standards might constrain vendor R&D or restrict users' options.

To determine the function of standards in different scenarios, we propose first to subdivide the question by technology domain and relative stability. Within such domains, policy-analytic research could address questions like the following: What will be the likely effects of standards in the near-term future? What is the role, if any, of de facto industry standards? Of large government agency acquisition, including DoD procurement? Of international bodies, markets, and competitors? How can user organizations influence industry standards?

SPECIAL PROJECTS

In addition to the general research agenda described above, the IIIE will also undertake special projects initiated by sponsors. Research designs will be developed to meet the specific objectives of special projects. Each will stand on its own scientific merit and be subject to Rand's regular review procedures.

Sponsors are encouraged to propose projects that, to the greatest extent possible, are coherent with and rely on ongoing IIIE research. Dovetailing special and general research in this way has dual benefits to the sponsor. First, it provides a broad, well-defined context within which to understand specific results. Second, since sponsors of special projects will bear the incremental costs of conducting them, it will also reduce their expenses.

III. RESEARCH METHODS AND DISSEMINATION

RESEARCH METHODS

Because of the complexity of the research agenda, IIIE projects will employ a wide range of research methods. Many of the research projects will require the collection of baseline information and the establishment of user contexts within which systems, techniques, models, and hypotheses can be examined and tested. For this reason, longitudinal and cross-sectional field research with interactive information technology in organizational settings--the implementation laboratory--will be the core procedure, with other types of methods providing important supplements as needed. Table 2 indicates how the proposed methods are related to specific research products.

Longitudinal Field Studies

We will recruit 2 to 4 large user organizations from the public and private sector and from information- and service-based as well as manufacturing industries for participation in longitudinal research. This set of organizations will provide the foundation for the implementation laboratory within which study questions can be explored and answered over time. Field sites need not be within IIIE sponsoring organizations. Sponsors will assist in identifying and recruiting appropriate field sites and may supply them, provided they meet research requirements.

In these settings, over a two- to three-year period, we expect to employ field experimental procedures (e.g., pilot projects, prototype adaptations, alternative implementation strategies) and varied data gathering methods (including observation, system instrumentation, abstracting of archival records, interviews). Researchers will sign standard nondisclosure agreements, making explicit the protection of proprietary information. However, nonidentified and nonsensitive data will become part of the IIIE's database, and findings will be incorporated into its reports.

Table 2

HOW PRODUCTS ARE RELATED TO METHODS

Research Products, by Topic Area	Major Methods							
	Longitudinal Field Research	Cross-Sectional Field Research	Conceptual Development	Policy Analysis	Modeling and Simulation	Secondary Data Analysis	Lab. Exp., Prototype Development	Elite Interviews
Implementation Projects								
Conceptual framework	X		X					
Implementation database	X	X						
New taxonomy of information entities	X	X	X					
Procedures for network and architecture planning	X	X			X		X	
Context-sensitive models of learning support	X	X					X	
Guidelines for interface design		X	X				X	
Impacts Projects								
Value-added models for assessing organizational performance	X		X		X	X		
Alternatives for redesigning jobs and staffs	X	X					X	
1990s Projects								
Demand models		X	X					X
Demand forecasts	X	X			X	X	X	X
Human resource projections		X			X	X		
Behavior settings projections		X	X				X	X
Alternative delivery scenarios		X	X					X
Assessment of standards policies				X		X		X

Cross-Sectional Field Studies

In addition to studying a small number of organizations intensively, we will develop a larger cross-section of organizations for more restricted repeated-measures study over the same time frame. The larger field sample will be selected to include a broader representation of organizations on dimensions of interest, to improve the generalizability of research results from longitudinal study sites and complete the implementation laboratory.

The longitudinal and cross-sectional field studies will provide multiple opportunities for validating our findings. Cross-sectional research will be useful for verifying hypotheses generated in longitudinal studies with a larger sample. It will also provide contexts for selected pilot trials, experimentation, or controlled comparison. In turn, we will be able to validate results from experimentation in cross-sectional research with more naturalistic methods (e.g., observation, qualitative data collection and analysis) in longitudinal studies.

Other Research Procedures

While longitudinal and cross-sectional field studies will provide the base of systematic empirical information on which IIIE research rests, varied other procedures will be employed as dictated by the focus of particular projects and their research designs.

Conceptual Development. Special emphasis will be placed on conceptual and analytic efforts because research on interactive information environments is still pre-paradigmatic; that is, theoretical foundations must be developed. Conceptual development can directly feed practical products. The UNIX message-handling (MH) system, for example, was designed by IIIE information scientist Norman Shapiro on the basis of observing and analyzing what people do with their mail.

Most projects will entail conceptual analysis and theory development, typically beginning with a critical review of relevant research. In some projects, such as the formulation of a new taxonomy of information "objects," these activities will be a major component.

Policy Analysis. Policy analysis is the application of scientific methods to problems of public policy. Most projects will have policy recommendations among their conclusions. In some projects, however, such as the proposed research on standards, assessment of policy options and their implications will be a central research activity.

Modeling/Simulation and Secondary Analysis. Some studies may rely heavily on the development and adaptation of statistical, mathematical, symbolic, or other models for representation and hypothesis testing (e.g., sociometric models of communication networks), or on numeric data simulation for exploring the implications of alternative metrics (e.g., approaches to performance measurement and projections of human resource requirements or technology demand). Simulation is an important step in determining the viability of proposed metrics and projections before attempting costly empirical data collection. Models may also be used to perform sensitivity analyses to determine the precision with which parameters must be measured to achieve the desired specificity in outcomes (e.g., for performance assessment). Finally, some research can rely on secondary analysis of extant data, particularly in initial stages (e.g., human resource implications of information technology should begin by examining available Census and Department of Labor data).

Laboratory Experimentation and Prototype Development. Laboratory experimentation refers here to experiments conducted outside of ongoing work (either at Rand or in other settings where appropriate equipment and facilities are available). Some projects--for instance, efforts to compare alternative interface designs or online learning processes--may require preliminary testing of experimental systems, tasks, or procedures. For these purposes, we will use traditional laboratory methods to obtain highly controlled observations and to avoid interruption of regular work in the field sites that comprise the implementation laboratory. Subsequently, promising experimental approaches could be applied in actual work contexts.

Prototype development will occur in the course of IIIE research when projects require software or hardware development or modification. As noted above, successful implementation processes are likely to

involve adaptation of systems to organizations. Probing the implications of this thesis may involve building and testing prototype systems by adapting off-the-shelf technologies or modifying those already in place for limited experimentation. Prototyping efforts may also arise in projects that attempt to transfer system capabilities from information science research to organizational use. For instance, available expert systems or strategic decision simulations (several of which have been designed in Rand's basic research program) might be adapted for complex information-handling tasks in organizations. Finally, it may be expedient to build or modify systems to permit the automatic or semiautomatic capturing of data as a function of technology acquisition, learning, or use.

Elite Interviews. Occasionally, projects may require collection of expert opinions, interpretations, or predictions. Identifying an appropriate sample of experts and soliciting participation in such efforts are labor intensive, but in many cases, the requisite data can be gained in no other way. (This may be the case, for example, in an investigation of the sources and roles of standards.) Rand's reputation for high-quality, objective research greatly facilitates elite interviewing.

RESEARCH DISSEMINATION

Because the IIIE is a research consortium, the dissemination of research results and products is closely coupled to the research process. Sponsors will participate in shaping the research topics and methods, will help select sites, will be briefed on research in progress, and will have the opportunity for early review of research results and products.

The Institute will foster informal, collegial interaction between research team members and interested sponsor representatives. For example, representatives of sponsor organizations will be welcome to sit in on parts of a research project that particularly interests them. Additionally, sponsor organizations can send to the IIIE "visiting researchers," members of their organization who have special interest or expertise in advanced information technology. The sponsoring organizations will cover their researchers' salaries, and the Institute

will provide offices and opportunities for participation in research activities.

When feasible, the Institute will also extend this opportunity to respected members of the academic community whose affiliation with the IIIE would be of mutual benefit.

The IIIE will host biannual conferences or workshops for sponsor representatives. These carefully prepared meetings will provide a rich forum for the exchange of information and for hands-on experience with research products. Meetings are especially important dissemination vehicles because they permit sponsor representatives to discuss findings, implications, and new research directions with their counterparts in other organizations.

When resources permit, IIIE researchers may visit sponsor organizations, at their request, to make presentations of findings to a larger audience in their own setting or to provide special assistance in applying the findings.

Research findings and products will be documented in forms that are useful and appropriate, tailored to the nature of the research and the needs of its prospective audiences. These forms will include technical reports, executive summaries, research and policy briefs, briefings, and special-purpose documents. All documentation will be subject to Rand's regular review process, which insures quality and objectivity.

IV. THE RAND RESEARCH ENVIRONMENT

The IIIE will build on a long tradition of interdisciplinary, empirical Rand research. For more than 30 years, Rand has been conducting sustained large-scale research efforts. Under both private and public sector sponsorship, investigators have addressed issues ranging from national security to urban management and the welfare of foreign countries. Rand has been able to undertake such varied and demanding projects because the corporation has an unusually wide base of expertise and experience.

Rand brings the following assets to the IIIE:

- A reputation for research conducted in the public interest according to rigorous standards of quality, objectivity, and independence.
- The proven capability to design, manage, and monitor large-scale, long-term, multidisciplinary research projects.
- Special expertise in areas central to the IIIE mission: a broad base of experience in social research and a history of significant contributions to computer and information sciences.
- Expertise in creating, analyzing, and protecting large and proprietary databases, plus the computer capacity to support these efforts.
- A well-documented capacity to understand sponsors' unique needs, to deliver useful and innovative research products, and to transfer scientific findings effectively.

Rand's reputation for strong, independent research has earned it a privileged position among both government and private sector organizations. This position has made it possible for Rand to give its sponsors the benefits of research based on proprietary information while avoiding conflicts of interest.

LARGE-SCALE, MULTIDISCIPLINARY RESEARCH

The goal of Rand's research is to improve the choices made by decisionmakers by helping them to understand the alternatives they face and the implications of their decisions. Basic to this undertaking is the identification of ways to reconcile the conflicting claims of economics, technology, and social priorities.

Diverse Professional Staff

To support the interdisciplinary research needed to address complex public issues, Rand has developed a diverse professional staff representing the political, behavioral, and social sciences; law; economics; information and computer sciences; operations research; statistics and mathematics; medicine; engineering and applied physical sciences; and the humanities. Seventy-four percent of the professional staff have advanced degrees. This wealth of in-house expertise enables Rand to assemble multidisciplinary teams appropriate for particular research topics. Moreover, projects can hire precisely the amount of expertise they need--half of a mathematician's time, for example, or one-fourth of an economist's.

Matrix Management

Such flexible and efficient staffing is possible because Rand is organized into a matrix of departments and research divisions. The departments house the professional staff according to speciality (e.g., Information Science, Behavioral Sciences). The divisions house research projects, usually grouped into ongoing programs (e.g., Health, Regulatory Policy). Project leaders can draw on researchers in any department.

Experience in Managing Research Centers

Although the IIIE is in many respects a unique venture, Rand has housed or currently houses several specialized research centers that are similar in concept.

- The Private Sector Sponsor Program (PSSP) was established to expand Rand research that addresses both public and private concerns, to insure that research results are transferred effectively to the private sector, and to promote interaction between Rand and industry staff. One PSSP program, the Processing Industries Program, had six sponsors and an annual operating budget of $700,000.
- The Institute for Civil Justice (ICJ), established within The Rand Corporation in 1979, performs independent, objective policy analysis and research on the American civil justice system. The ICJ has more than 200 sponsors and operates at a funding level of about $2.2 million annually.
- Rand's Center for the Study of the Teaching Profession, initiated in the spring of 1985, will not only analyze the policies that affect teachers and teaching, but will also help design, implement, and evaluate reform efforts.

SPECIAL EXPERTISE IN SOCIAL EXPERIMENTATION

Rand's capability for long-term research projects is evident in its longitudinal social experiments. Rand has undertaken experiments in such diverse areas as health insurance, housing assistance, educational vouchers, electric power rate setting, and school-based preventive dentistry. These multi-year experiments illustrate Rand's extensive experience in both qualitative and quantitative analysis. They have also given Rand staff experience in constructing, managing, and sharing large longitudinal databases. Two examples:

- The Health Insurance Study, a ten-year effort, is a large-scale controlled experiment designed to obtain policy-relevant information about medical outcomes and treatment costs not available through the analysis of nonexperimental data alone.
- A longitudinal study for the Los Angeles Department of Water and Power examined data from 2,000 households and varied pricing structures over a three-year period to test the hypothesis that electricity customers will adapt their consumption patterns to take advantage of lower rates.

SPECIAL EXPERTISE IN INFORMATION SCIENCES

From the earliest days of digital computing and artificial intelligence, Rand has pioneered in the development and application of new hardware and software technologies. John Von Neumann, Alan Newell, Herbert A. Simon, and Richard Bellman are among the many distinguished scientists responsible for Rand's contributions to the information sciences.

Landmark achievements include the following:

- JOHNNIAC, one of the first stored-program computers.
- JOSS, the first truly interactive computing system.
- The Rand Videographics System, one of the first interactive graphics systems using raster-scan technology.
- The General Problem Solver, a very early computer program for exploring the mechanisms of problem solving.
- The development of some of the first symbol-manipulating and list-processing languages.
- The invention of Linear Programming and Dynamic Programming.
- The Rand Editor and the Message Handler, two powerful interactive tools exemplifying the UNIX philosophy of small, self-contained executable modules.
- ROSS, an English-like, object-based simulation language.
- ROSIE, a highly English-like language designed specifically for building expert systems.
- The Rand Strategy Assessment Center, the largest and most complex AI-assisted system yet built for decisionmaking support.

Dominating these achievements is a concern with facilitating human/machine interaction. Rand research has continually developed and refined human-oriented interfaces and environments that make information systems easier to design, implement, debug, understand, and use. This tradition will be continued by IIIE research.

SAFEGUARDING SENSITIVE PROPRIETARY DATA

The research agenda of the IIIE requires the construction of large databases that include proprietary data. Rand's policy is to safeguard all private or proprietary information generated by or provided to Rand in connection with its research. The Rand Privacy Resource Office defines and maintains data safeguarding guidelines and services consistent with corporate policy and with client requirements. Security procedures may vary from project to project, and within a single project at different stages, but extensive routine security practices are always in place.

RESPONSIVENESS TO SPONSORS

Rand researchers have a well-documented history of working closely and cooperatively with the staff of sponsoring organizations. The corporation has regularly demonstrated its capacity for understanding sponsors' unique needs and for developing and transferring materials and tools tailored to meet those needs.

The chief goal of the IIIE is to deliver useful, innovative tools that will facilitate the design, implementation, and evaluation of large-scale advanced information systems in user settings. Rand has repeatedly demonstrated the capability to develop such tools for its sponsors. Recent examples:

- Over the last decade, Rand's Energy Policy Program has developed new types of innovative assessment tools to help decisionmakers make realistic estimates of the cost, schedule, and performance of energy projects. These models statistically link characteristics of the technology, of the research and development effort, and of the management approach to project outcomes. They are particularly valuable in applications that involve major technical, economic, and institutional uncertainties.
- Rand's Strategy Assessment Center has developed a very large-scale, finely grained simulator and gaming system for

investigating international conflict. It needed a new language for this purpose, so RAND-ABEL was designed by the IIIE's principal information scientist. Used to govern the behavior of decisionmaking entities in simulation, RAND-ABEL uses English-like properties so that nonprogrammers can understand and manipulate it. Strategy analysts can interact with the simulation, observe and learn from the consequences of alternative choices, and ultimately improve international conflict management.

V. SPONSORSHIP AND GOVERNANCE

SPONSORSHIP

The Institute for Interactive Information Environments is a special research and educational organization within The Rand Corporation's Domestic Research Division.

Sponsorship is open to both public and private-sector organizations. Each sponsor is asked to provide The Rand Corporation with a three-year research grant, renewable annually. The grant amount is set at $50,000 annually. Industrial sponsors of the IIIE qualify for a tax credit under the Basic Research provisions of the Economic Recovery Tax Act of 1981.

Sponsors are invited to participate in biannual problem definition meetings and seminars. Sponsors understand that all Rand research is conducted in the public interest. This means that any work carried out within the IIIE will be made available in public research reports; however, data will be presented only in aggregate form, and other steps will be taken to safeguard proprietary information and to conceal the identities of participating organizations and individuals. Sponsors will have the right of prior review of IIIE reports.

Sponsors and the Research Advisory Board will assign priorities to projects in the research agenda, which may be proposed by IIIE researchers or by sponsor representatives. Institute staff will set the final research agenda, reflecting these priorities and balancing them against the available level of resources.

COMMITMENT

If a sufficient number of sponsor commitments are obtained, Rand management will formally initiate the Institute. Actual funding by sponsors will begin only after formal startup; at that time, sponsors will be invoiced for payment of the annual fee. Fee payments can be made periodically, if this is more convenient for the sponsoring organization, and memberships may commence and expire throughout the year.

SPECIAL PROJECTS

Sponsors may propose that the IIIE undertake research that is of special interest to them and is also of general relevance to the Institute's research agenda. In such cases, the Institute will provide the sponsor with a formal proposal for a research grant. The results of special projects, purged of identifying proprietary information, will be reviewed and disseminated in accordance with normal Rand procedures.

GOVERNANCE

Within Rand, the Institute will have a Director, appointed by Rand, reporting to the Vice President, Domestic Research. The Director will assume overall leadership responsibility, with responsibility for major fiscal and operational decisions. The Director will share responsibility for maintaining the scientific quality of the Institute's work with senior research scientists. Research projects will follow established Rand procedures for organization and project management.

The Director will be assisted in the guidance of the Institute by a Research Advisory Board (RAB). This Board will have ten members, five appointed by Rand and five nominated and elected by the Sponsor Group. The Institute Director and the Vice-President, Domestic Research, will be ex officio members of the Board. The Board's major responsibility will be to provide guidance and counsel on the determination of research directions, opportunities, and priorities for the Institute. The RAB will meet twice yearly, in conjunction with the general sponsor meetings. The RAB will issue reports to the membership on the results of its work and recommendations.

REPRESENTATIVE RAND PUBLICATIONS[1]

Alexander, A. J., and B. M. Mitchell, *Measuring Technological Change of Heterogeneous Products*, The Rand Corporation, R-3107-NSF, 1984.

Anderson, R. H., and N. Z. Shapiro, *Design Considerations for Computer-Based Interactive Map Display Systems*, The Rand Corporation, R-2382-ARPA, 1979.

Besen, S. M., *Private Copying, Reproduction Costs, and the Supply of Intellectual Property*, The Rand Corporation, N-2207-NSF, 1984.

Besen, S. M., "The Regulation of Telecommunications Networks," *The Information Society*, Vol. 2, 1984, pp. 359-380.

Besen S. M., and L. L. Johnson, *Regulation of Media Ownership by the Federal Communications Commission: An Assessment*, The Rand Corporation, R-3206-MF, 1984.

Bikson, T. K., and B. A. Gutek, "Training in Automated Offices: An Empirical Study of Design and Methods," *Training for Tomorrow*, Joint International IFAC/IFIP Conference, Leiden, The Netherlands, 1983 (published as a book by Pergamon Press, 1984).

Bikson, T. K., and B. A. Gutek, *Advanced Office Systems: An Empirical Look at Utilization and Satisfaction*, The Rand Corporation, N-1970-NSF, 1983.

Bikson, T. K., B. A. Gutek, and D. A. Mankin, *Implementation of Information Technology in Office Settings: Review of Relevant Literature*, The Rand Corporation, P-6697, 1981.

Bikson, T. K., D. A. Mankin, and C. Stasz, *Computer-Mediated Work: Individual and Organizational Impacts in a Corporate Headquarters*, The Rand Corporation, N-2328-OTA, 1985.

Bikson, T. K., B. Quint, and L. L. Johnson, *Scientific and Technical Information Transfer: Issues and Options*, The Rand Corporation, N-2131-NSF, 1984.

Dertouzos, J., and T. Quinn, *Bargaining Responses to the Technology Revolution: The Case of the Newspaper Industry*, The Rand Corporation, R-3144-DOL, 1985.

[1]Copies of these publications may be obtained through Rand's Publications Department, The Rand Corporation, 1700 Main Street, Santa Monica, California 90406-2138, (213) 393-0411.

Gutek, B. A., T. K. Bikson, and D. A. Mankin, "Individual and Organizational Consequences of Computer-Based Office Technology," in *Applied Social Psychology Annual*, Vol. 5, Sage Publications, Beverly Hills, Calif., 1984.

Harman, A. J., A. Alexander, M. R. Davis, and A. D. Lee, *Technological Innovation by Firms: Enhancement of Product Quality*, The Rand Corporation, R-2337-NSF, 1977.

Hayes-Roth, F., P. Klahr, and D. J. Mostow, *Knowledge Acquisition, Knowledge Programming, and Knowledge Refinement*, The Rand Corporation, R-2540-NSF, 1980.

Hayes-Roth, F., D. A. Waterman, and D. B. Lenat (eds.), *Building Expert Systems*, Addison-Wesley, Reading, Mass., 1983.

Klahr, P., and D. A. Waterman, "Artificial Intelligence: A Rand Perspective," in *Expert Systems: Techniques, Tools, and Applications*, Addison-Wesley, Reading, Mass. (forthcoming).

Mankin, D. A., T. K. Bikson, and B. A. Gutek, "Factors in Successful Implementation of Computer Based Information Systems: A Review of the Literature with Suggestions for Research," *Journal of Organizational Behavior Management*, Vol. 6, No. 3/4, 1984, pp. 1-20.

McArthur, D., P. Klahr, and S. Narain, *ROSS: An Object-Oriented Language for Constructing Simulations*, The Rand Corporation, R-3160-AF, 1984.

Shapiro, N. Z., and R. H. Anderson, *Toward An Ethics and Etiquette for Electronic Mail*, The Rand Corporation, R-3283-NSF/RC, 1985.

Talbert, L., T. K. Bikson, and N. Z. Shapiro, *Interactive Information Environments: A Plan for Enabling Interdisciplinary Research*, The Rand Corporation, N-2115-NSF, 1984.

Ware, W. H., *Information and Communications Protection*, The Rand Corporation, P-7033, 1984.

Ware, W. H., *Information Systems, Security, and Privacy*, The Rand Corporation, P-6930, 1983.

Waterman, D. A., and F. Hayes-Roth, *An Investigation of Tools for Building Expert Systems*, The Rand Corporation, R-2818-NSF, 1982; also in Hayes-Roth, Waterman, and Lenat (eds.), *Building Expert Systems*, 1983.

Winkler, J. D., and C. Stasz, *A Survey of Incentives for Staff Development of Computer-Based Instruction*, The Rand Corporation, P-7087, 1985.